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海岸带生态系统服务价值评估及其在海岸带管理中的应用研究

Evaluation of Coastal Ecosystem Services and Its Application in the Coastal Zone Management

彭本荣

指导教师姓名：洪华生 教授

专 业 名 称：环境科学

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学位授予日期：

答辩委员会主席：陈振明教授、博导

评　　阅　　人：李永祺 教授、博导

恽才兴 教授、博导

杨志峰 教授、博导

高之国 教授、博导

赵　　晔 教授、博导

金　　堤 教授、博导

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摘要

海岸带地区人们的生存和发展依赖于海岸带生态系统所提供的各种产品和服务。但是，随着人类对生态系统产品和服务需求的日益增加，人类活动却在导致海岸带生态系统提供产品和服务的能力持续降低。研究海岸带生态系统服务及其价值评估方法，并将价值评估的信息纳入到海岸带管理决策之中，对海岸带地区的可持续发展具有重要的理论价值和现实意义。

本论文综合应用环境科学、环境经济学、资源经济学以及生态学等学科的知识和技术方法，理论研究与实证分析相结合，系统探讨了海岸带生态系统服务价值评估及其在海岸带管理中的应用，取得了如下研究成果：

1）通过对海岸带生态系统退化原因的经济学分析以及海岸带管理模式变迁的研究，本论文提出了海岸带管理决策应以生态系统服务价值为基础，并以生态系统作为管理单元的观点。

2）在研究海岸带生态系统结构、过程、功能和服务的含义以及它们之间相互关系的基础上，通过对海岸带生态系统土地覆盖、功能多样性和生境多样性的考察，与学术界关于生态系统服务分类的最新研究成果相结合，建立了海岸带生态系统及其服务的识别和分类系统。

3）综合分析了海岸带生态系统的两种价值范式以及它们在海岸带管理中的作用；建立了综合的海岸带生态系统服务价值评估框架；同时探讨了不同海岸带生态系统服务价值评估的技术选择。

4）建立了同时包含多个海洋产业部门和资源环境部门的、研究海岸带综合管理社会经济总效益的系统框架，并将建立的模型应用到厦门的实践，在学术界首次完成了海岸带综合管理总效益的经验评估。

5）建立了海岸带综合管理公平性分析框架，并对厦门西海域综合整治的公平性进行了分析。同时建立了海岸带综合管理受损部门补偿标准的估算方法以及受益部门成本分摊份额的估算方法。

6）建立了一系列生态-经济模型，包括海域空间资源价值评估模型、海域环境容量价值评估模型、填海造地生态损害价值评估模型以及被填海域作为生产要素的价值评估模型。用所建立的模型评估了厦门海岸带生态系统服务的价值，

为厦门海岸带管理经济刺激手段的制定提供了科学依据。

关键词：海岸带生态系统；价值评估；社会经济效益；公平性分析；生态损害评估；海域使用金；经济刺激手段

Abstract

Human well-being and development of coastal zones has always depended on the services provided by the coastal ecosystems. While demands for ecosystem services such as food and clean water are growing, human actions are diminishing the capability of many ecosystems to meet these demands. Human activities have led to the significant changes of ecosystems' scopes, distributions and conditions. Globe coastal zones face the great pressure from economic development and population growth. Human activities have been the main driving forces affecting the coastal shape and coastal ecosystems. It is very important theoretically and practically for sustainable development in coastal zones to study the value of coastal ecosystem services and evaluation methods and to integrate the value information into the coastal zone management.

This dissertation presents a systematic evaluation of services provided by the coastal ecosystem and its application in the coastal zone management using multidiscipline theories and methodologies, including environmental science, ecological science, resources economics and environmental economics. Combining theory with positive analysis, this study contributes to the literature on ocean and coastal management research in seven ways.

First, the study demonstrates that coastal zone management decision should be based on the value of coastal ecosystem services and should be ecosystem-based. The conditions and trends in changing capacity of coastal ecosystems are summarized and demonstrated at the outset. Through economic analysis of coastal ecosystem issues and study of the evolution of globe coastal zones management models, we conclude that the coastal zone management, including decision-making and design of economic instruments, should be based on the value of ecosystem services and the management area should combine marine ecosystem with estuary ecosystem and the watersheds that drain into them. The application of coastal ecosystem service evaluation in coastal zone management is also discussed.

Second, a framework for identifying and classifying coastal ecosystems and services provided is developed. Identifying and defining the coastal ecosystems and their services are essential components in the valuation and management of coastal systems. There is no well developed framework to identify the coastal ecosystems and their services although there have been a number of articles on the evaluation of coastal ecosystem services in the existing literature. Employing a global land use classification system with a high level of standardization (FAO-LCCS), classification of coastal systems of Coastal Systems of Europe (CSE) and typologies of the Land-Ocean Interactions in the Coastal Zone (LOICZ) program, and adapting to the recently developed typology of the system of ecosystem services in the literature, the study establishes a formal system for classifying the coastal ecosystems and their services based on the definitions and relationships among processes, functions, and services of coastal ecosystems, and on land coverage, functional diversity and habitat diversity of coastal systems.

Third, the study examines systematically the evaluation methods for ecosystem services, develops an integrated frame work to assess the value of coastal ecosystem services, and establishes a procedure for selecting feasible techniques to evaluate various services. We

examine the utilitarian and non-utilitarian value of coastal ecosystems and services provided by them, and the role of these two valuation approaches in the decision making of coastal ecosystem management. We establishes a conceptual framework for the assessment and valuation of services provided by coastal ecosystems, which considers the ecological structures and processes, land use decisions, human welfare and the feedbacks between them. The study reviews and compares the valuation techniques of various services provided by coastal systems, and establishes the best feasible order of methods to evaluate the coastal ecosystem services.

Fourth, the study develops a systematic approach for the measurement of overall socioeconomic benefits associated with an integrated coastal management (ICM) program. Integrated coastal management (ICM) is an accepted management framework to address coastal and marine environmental problems and to achieve sustainable use of coastal resources. Scholars agree that one indicator for assessing the success of an ICM program is its socioeconomic benefits. Although conceptual framework for ICM benefit-cost analysis has been discussed in the literature, there has been little attempt in the research community to develop empirical assessment of the overall benefit associated with an ICM program. We develop a systematic approach for the measurement of overall socioeconomic benefits associated with an integrated coastal management (ICM) program. The analytical framework includes multiple marine industry sectors (e.g., ocean shipping and commercial fisheries) as well as environmental and resource sectors (e.g., water quality and endangered species). The net benefit measure captures both economic and environmental effects. We apply our analytical model to Xiamen, China, using empirical data from 1992 to 2001. Results of the case study show that the implementation of ICM program in Xiamen has led to a significant increase (80%) in annual socioeconomic benefit from its marine sectors. Thus, the Xiamen ICM program has been effective in achieving sustainable development.

Fifth, the study presents a framework to analyze the equity of ICM. The distribution of benefits and costs of ICM among different income groups and between inter-generation is the key factor to determine if ICM can be implemented smoothly. However, there has been little efforts in the research community to develop equity analysis of ICM. The analytical framework developed in the study includes both intra- and inter-generation equity analyses. Net welfare change and benefit-cost ratios for each affected groups with and without ICM are employed to determine the intra-generation equity of CIM. The changes in society's total capital stocks and the natural capital stocks are used to determine the inter-generation equity. The analytical models are applied to Xiamen, China, using data from Integrated Treatment of Western Seas (ITWS) project, which is the initiative program of the second round ICM in Xiamen. The result show that there are serious intra-generation equity issues in ITWS although the overall benefits of ITWS are far greater than the costs. The loser is the fisheries sector, whose welfare decreases significantly after ITWS. To improve the policy, we develop two models to estimate separately the compensation standard to losers and the shares of contribution by winners to a compensation fund under ICM.

Sixth, the study constructs an economic model to assess the value of marine space and marine environmental capacity to provide sound basis for economic instruments under ICM. While marine environmental destruction and marine resource over-exploitation are urgent

challenges facing us today, the value of marine spatial resources continues to be overlooked and undervalued. We have begun to reach the limits of the oceans and must now begin to utilize and govern them in a sustainable way. Imposing usage charges in sectors that utilize marine areas for production or for waste disposal would be an efficient economic instrument to discourage waste, optimize distribution, promote conservation and provide funds to improve sea areas health. The essential task for establishing the usage charges for marine spaces is to estimate the value of marine areas. Based on the theory of valuation of marine spaces, two operating models are developed to assess the value of marine spaces and the value of marine environmental capacity. And the models are applied to price different types of marine spatial functions in Xiamen. The results establish marine usage charge for the Xiamen government.

Finally, the study presents a series of ecological economic models to appraise the ecological damage and value of filled seas as production factors to provide scientific support for the decision making of coastal reclamation planning and policy. Coastal reclamation usually means that the sea is filled with land to create more useful land area. The reclamation, however, results in heavy losses to ecosystems of the coastal environment. The value of filled seas as production factors and ecological damage of sea reclamation must be integrated into the decision-making in planning and policy to ensure sustainable development of coastal zones. We apply the models to Xiamen and find that the values of filled seas for industrial zone and for commercial use are 48.82 yuan/m^2 and 1251.4-1572.04 yuan/m^2, respectively; the value of ecological damage of sea reclamation is 279 yuan/m^2. The present usage charges are so low that they do not include the full costs of sea reclamation and should be modified to 327.82 yuan/m^2 for industrial use and 50%-55% of the adjacent land prices for commercial use.

Keywords Coastal ecosystem; Services of ecosystem; Evaluation; Benefits-costs analysis; Equity analysis; Ecological-economic models, Ecological damage, Xiamen

目 录

摘要 i
Abstract iii
图表目录 xv
Tables and Figures xvii
第一章 绪论 1
1.1 引言 1
1.2 国内外研究进展 4
1.2.1 生态系统服务及其价值 4
1.2.2 海岸带生态系统服务价值评估 7
1.2.3 海岸带管理决策评估 9
1.2.4 海岸带管理经济刺激手段 11
1.3 国内外研究存在的问题分析 13
1.3.1 理论方面存在的问题 13
1.3.2 应用方面存在的问题 14
1.4 本论文研究内容和技术路线 15
1.4.1 研究目标 15
1.4.2 研究内容 16
1.4.3 技术路线 18
理论研究篇 21
第二章 生态系统服务价值——海岸带管理的基础 22
2.1 引言 22
2.2 海岸带生态系统服务状况和变化趋势 23
2.2.1 海岸带生态系统存在问题 24
2.2.2 海岸带生态系统提供服务的能力变化趋势 26
2.3 海岸带生态系统退化的经济学透视 29
2.3.1 海岸带生态系统面临的最基本压力：人口和消费 29
2.3.2 市场失灵 31
2.3.3 政府失灵 34
2.4 海岸带管理模式变迁 37
2.5 基于生态系统服务价值的海岸带管理 41
2.5.1 生态系统服务价值是海岸带管理决策的基础 41
2.5.2 基于生态系统价值的海岸带综合管理手段 43
2.5.3 海岸带生态系统服务价值在海岸带管理中的应用 47
第三章 海岸带生态系统及其服务：识别与分类 50
3.1 引言 50
3.2 基本概念 51
3.2.1 生态系统 51
3.2.2 生态系统服务 52
3.3 海岸带生态系统的边界和范围 54
3.3.1 生态系统边界确定的标准 54
3.3.2 海岸带生态系统的范围 56
3.3.3 海岸带地区生态系统识别和分类 57

3.4 海岸带生态系统服务 60
3.4.1 全球性生态系统服务的识别和分类 60
3.4.2 海岸带生态系统服务识别 63
3.5 海岸带生态系统服务的可持续性 67
3.5.1 海岸带生态系统状况与服务的可持续性 68
3.5.2 生物多样性和海岸带生态系统服务 69
3.5.3 生态系统稳定性与海岸带生态系统服务 70
3.5.4 海岸带生态系统服务的替代性 72
第四章 海岸带生态系统服务价值及其评估技术 75
4.1 引言 75
4.2 价值范式与海岸带生态系统服务价值分类 76
4.2.1 功利主义价值范式与海岸带生态系统服务价值分类 77
4.2.2 非功利主义的价值范式 81
4.2.3 两种价值范式的关系及其在管理决策中的应用 82
4.3 海岸带生态系统价值评估框架 84
4.4 海岸带生态系统经济价值评估方法 85
4.4.1 经济价值的基本概念 85
4.4.2 海岸带生态系统价值评估方法分类 87
4.4.3 直接市场法 90
4.4.4 间接市场法 91
4.4.5 假想市场法 93
4.4.6 收益转移法 96
4.4.7 价值评估方法的选择 97
4.5 海岸带生态系统服务价值评估的实践问题 99
4.5.1 海岸带生态系统服务变化价值评估 99
4.5.2 海岸带生态系统服务价值评估的尺度 101
实证分析篇 103
第五章 厦门海岸带综合管理社会经济效益分析 104
5.1 引言 104
5.2 方法和技术 106
5.3 海岸带综合管理的收益和成本识别 109
5.3.1 海岸带综合管理收益识别基本框架 109
5.3.2 厦门海岸带综合管理 111
5.3.3 厦门海岸带综合管理收益 113
5.3.4 海岸带综合管理成本 114
5.4 经验评估 115
5.4.1 数据 115
5.4.2 海岸带综合管理的收益 117
5.4.3 海岸带综合管理成本 125
5.4.4 海岸带综合管理净效益和敏感性分析 126
5.5 本章结论与讨论 128
5.5.1 研究结论 128
5.5.2 存在问题和将来研究方向 129

第六章 海岸带综合管理公平性分析：厦门案例研究 130
6.1 引言 130
6.2 方法与技术 131
6.2.1 代内公平分析方法 132
6.2.2 代际公平分析方法 133
6.2.3 公平性分析的步骤 134
6.3 厦门西海域综合整治的公平性分析 136
6.3.1 背景 136
6.3.2 受西海域综合整治影响的群体分析 137
6.3.3 受影响群体福利估算 138
6.3.4 西海域综合整治代内公平性综合分析 150
6.3.5 西海域综合整治代际公平性分析 151
6.4 受损部门的补偿标准及补偿机制 152
6.4.1 受损部门补偿标准 152
6.4.2 受损部门补偿机制 155
6.5 本章结论与讨论 156
第七章 厦门海域价值评估及其在海域使用金征收标准制定中的应用研究 158
7.1 引言 158
7.2 海域价值与价格：理论与方法 160
7.2.1 海域的价值与价格 160
7.2.2 海价评估方法 163
7.3 海域使用金征收标准建立步骤 169
7.3.1 海域分区 169
7.3.2 海域分级 170
7.3.3 海域使用类型 171
7.3.4 政策因素 172
7.4 厦门海域使用金征收标准经验估算 173
7.4.1 数据 173
7.4.2 海域价格估算过程和结果 174
7.4.3 海域使用金征收标准 179
7.5 本章结论与讨论 184
7.5.1 本章研究结论 184
7.5.2 讨论与展望 185
第八章 填海造地生态损害评估及其在经济手段制定中的应用 186
8.1 引言 186
8.2 方法和模型 188
8.2.1 填海造地的生态损害 188
8.2.2 填海造地生态损害价值评估模型 192
8.2.3 被填海域作为生产要素的价值评估模型 196
8.2.4 填海造地海域使用金标准估算模型 198
8.3 厦门案例研究 200
8.3.1 数据 200
8.3.2 填海造地生态损害价值 201
8.3.2 填海造地海域作为生产要素的价值 204

8.3.3 填海造地海域使用金征收标准 204
8.4 本章结论与讨论 206
第九章 论文总结 208
9.1 结论 208
9.2 创新点 211
9.3 不足之处和研究展望 212
参考文献 214
致 谢 232
附录：博士生期间参加课题及发表论文 233

TABLE OF CONTENTS

Abstract (Chinese)
Abstract in English
List of Figures and Tables
Chapter 1 Introduction ……1
1.1 Background ……1
1.2 Literature Reviews ……4
1.2.1 Ecosystem Services and Their Value ……4
1.2.2 Evaluation of Services Provided by Coastal Ecosystems ……7
1.2.3 Assessment of Coastal Zone Management Decision ……9
1.2.4 Incentives of Coastal Zone Management ……11
1.3 Issues and Deficiency in Present Research ……13
1.3.1 Issues in Theory Study ……13
1.3.2 Deficiency in Application ……14
1.4 Thesis Introduction ……15
1.4.1 Objectives ……15
1.4.2 Main Content ……16
1.4.3 Technologies and Approaches ……18
Part I Theory ……21
Chapter 2 Ecosystem and Value-based Coastal Zone Management ……22
2.1 Introduction ……22
2.2 Conditions and Changing Trends of Capacity of Coastal Zone Ecosystems ……23
2.2.1 Coastal Ecosystems Issues ……24
2.2.2 The Changing Trends of Capability Providing Services of Coastal Ecosystems ……26
2.3 Economics Analysis of Reason of Coastal Ecosystems Degradation ……28
2.3.1 Basic Drivers: Population and Consumption ……29
2.3.2 Market Failure ……30
2.3.3 Government Failure ……34
2.4 Transformation of Coastal Zone Management Models ……36
2.5 Ecosystem and Value-Based Coastal Zone Management ……40
2.5.1 Value of Ecosystem Services is the base of coastal Zone Management ……40
2.5.2 Economic Instruments of Value-based Coastal Zone Management ……42
2.5.3 Application Regime of Evaluation of Coastal Ecosystem Services ……46
Chapter 3 Coastal Ecosystems and Their Services: Identifying and Classifying ……48
3.1 Introduction ……48
3.2 Concepts and Definition ……49
3.2.1 Ecosystems ……49
3.2.2 Services Provided by Ecosystems ……50
3.3 Scope and Boundary of Coastal Ecosystems ……52
3.3.1 Indicator to Determine Ecosystems' Boundary ……52
3.3.2 Scope of Coastal Ecosystems ……54
3.3.3 Identifying and Classifying System of Coastal Ecosystems ……55
3.4 Services Provided By Coastal Ecosystems ……57

3.4.1 Typology of Globe Ecosystem Services ……58
3.4.2 Identifying and Typology of Services Provided by Coastal Ecosystems ……61
3.5 Sustainability of Coastal Ecosystem Services ……65
3.5.1 Sustainability of Services and Conditions of Coastal Ecosystems ……66
3.5.2 Biodiversity and Coastal Ecosystem Services ……67
3.5.3 Variety and Stability and Coastal Ecosystem Services ……68
3.5.4 Substitutability of Coastal Ecosystem Services ……70
Chapter 4 Value and Evaluation Techniques of Coastal Ecosystem Services ……73
4.1 Introduction ……73
4.2 Value Approaches and Groups of Coastal Ecosystem Services ……74
4.2.1 Utilitarian Value Approach ……75
4.2.2 Non Utilitarian Value Approach ……79
4.2.3 The Relationship of Two Value Approaches and Their Roles in Coastal Zone Management Decision Making ……80
4.3 Integrated Framework for Evaluation of Coastal Ecosystem Services……82
4.4 Economic Valuation Methods of coastal Ecosystem Services ……83
4.4.1Concept and Theory of Economic Value ……83
4.4.2 Categories of Methods to Evaluate the coastal Ecosystem Services ……85
4.4.3 Direct Markets Method ……88
4.4.4 Indirect Market Methods ……89
4.4.5 Supposing Market Methods ……91
4.4.6 Benefit Transfer ……94
4.4.7 Comparing and choice of Evaluation Methods ……94
4.5 The Practice Issues of Evaluation of Coastal Ecosystem Services ……97
4.5.1 The Assessment of Changing of Value of Coastal Ecosystem Services ……97
4.5.2 The Scale Issues in the Evaluation of coastal Ecosystem Services ……99
Case Study……101
Chapter 5 Socioeconomic Benefits Analysis of Integrated Coastal Management in Xiamen ……102
5.1 Introduction ……102
5.2 Approach and Methods ……104
5.3 Identifying the Benefits and Costs of ICM ……107
5.3.1 Framework of Identification……107
5.3.2 ICM in Xiamen ……110
5.3.3 Benefits of ICM in Xiamen ……112
5.3.4 Costs of ICM in Xiamen ……113
5.4 Empirical Assessment ……114
5.4.1 Data ……114
5.4.2 Estimation of Benefits ……116
5.4.3 Estimation of Costs ……124
5.4.4 Net benefits of ICM and Sensibility Analysis ……125
5.5 Summary and Discussion ……126
5.5.1 Research Conclusion ……126
5.5.2 Issues and Future Research ……128

Chapter 6 Equity Analysis of ICM: Case Study of Xiamen ……...129
6.1 Introduction ……..129
6.2 Approach and Methods ……..130
6.2.1 Framework for Intra-generation Equity Analysis ……..131
6.2.2 Framework for Inter-generation Equity Analysis ……...132
6.2.3 Steps for Equity Analysis ……...133
6.3 Equity Analysis of Integrated Treatment of West Seas (ITWS) in Xiamen ……...135
6.3.1 Background ……...135
6.3.2 Impacted Groups ……...136
6.3.3 Assessment of Welfare of Impacted Groups ……...137
6.3.4 Intra-generation Equity Analysis of ITWS ……...149
6.3.5 Inter-generation Equity Analysis of ITWS ……...150
6.4 Compensation Standard and Mechanisms to Loser of ITWS ……...151
6.4.1 Compensation Standard ……...151
6.4.2 Compensation Mechanism ……...154
6.5 Summary and Discussion ……...155
Chapter 7 Evaluation of Seas and Its Application in the Establishment of Marine Usage Charge ……157
7.1 Introduction ……157
7.2 Value and Price Theory and Evaluation Methods of Seas ……159
7.2.1 Value and Price of Seas ……159
7.2.2 Assessment Methods of Marine Prices ……162
7.3 Methods of Establishing Marine Usage Charges ……168
7.3.1 Zoning of Marine Spaces ……168
7.3.2 Grading of Marine Spaces ……169
7.3.3 Using Type of Marine Spaces ……170
7.3.4 Policy Coefficient ……171
7.4 Empirical Assessment ……171
7.4.1 Data ……172
7.4.2 Estimation of Marine Prices ……173
7.4.3 Establishment of Marine Usage Charge of Xiamen ……178
7.5 Summary and Discussion ……183
7.5.1 Conclusion ……183
7.5.2 Discussion ……184
Chapter 8 Ecological Damage appraisal of Sea Reclamation and It's Application in the Policy Making about Reclamation ……185
8.1 Introduction ……185
8.2 Approaches and Methods ……187
8.2.1 Ecological Damage of Sea Reclamation ……187
8.2.2 Assessment Models of the Value of Ecological Damage ……191
8.2.3 Assessment Model of Value of Filled Seas as Production Factors ……195
8.2.4 Establishment of Usage Charge of Sea Reclamation ……197
8.3 Case Study of Xiamen ……199
8.3.1 Data ……199